Subject: Electrical Basic Concepts and Understandings Needed For After a PS.
Date: 3 Oct 05

Electricity is the flow of electrons. Electrons are a very small particle with a negative charge. Electricity being a particle flow is analogous to water flow. Consider the following picture of two buckets one full and the other empty of water. See attached figure
http://home1.gte.net/mikelob/WaterBuckets1.pdf
This represents a fully charged single cell battery. When the water level on both sides is equal then the battery is considered to be discharged.

The hand pump represents energy stored as chemical energy in the battery. When the person gets tired of cranking and stops cranking the water on both sides will soon reach the same level. This is what happens when a battery is fully discharged and all of it's chemical energy is expended.

Each type of battery has different chemistry. The details of each are not important to understand right now. The important concept to grasp is that in a chemical reaction can be stored the pressure of pushing electrons in a given direction. When discharging occurs the chemical reaction is going into a lower energy state and forcing electrons to be pushed out of the negative plate in a battery with a given pressure or voltage. Chemical reactions are basically moving ions (charged chemicals) or electrons from one place to another while in a solution that allows for that flow.

It is like giving food to the person running the hand pump in the water flow analogy. Take away the food and the pump stops. The direction of electrical flow is determined by the element and compounds used for each plate. The reaction is usually reversible one can pump electrons in the reverse direction to charge the battery and store energy as a chemical reaction.

Another important concept is electrons are not being created in a battery they are only being pumped or pushed from one side to the other because of the stored chemical energy.

DC stands for direct current and is a flow in one direction. AC stands for Alternating Current and is a push pull flow. AC would be like if someone reversed the terminals of a battery every so often. Say at the rate of 60 times per min.

Current is measured in amperes. One amp is 6,300,000,000,000,000,000 electrons flowing in a conductor past a given point in one sec. This is not important to

remember. The main concept to remember is one amp is a large quantity of electrons flowing past a given location in one sec. In the water analogy this would be the same as counting the number of water molecules that go past a given location. This again would be a very large number so we typically measure this as volume flow in cubic feet per minute or more practically buckets full/hour. Get the idea hear no one likes to work with large numbers so in like manner the word amperes has been assigned a given quantity flow of electrons in a unit of time.   Now rather than count electrons each time we can measure them by the bucket full/sec or by simply by saying so many amps.

Voltage is analogous to pressure. In the water analogy the higher the water on the right side the higher the pressure. In like manner Voltage is the amount of pressure behind any given electron to cause it to move along the conductor. Pressure in water is measured in lbs per square inch.   One Volt is the amount of pressure necessary to force one Amp of electrons through a resistor of one Ohm producing one Watt of power. We have all felt the heat from a 100 watt light bulb. So we have an idea of what one watt would approximately be.

Ohm is a unit of electrical resistance equal to the resistance between two points on a conductor when a potential difference of one volt between them produces a current of one ampere. This just an arbitrary amount of resistance based on earlier defined terms.

A watt is the product of the voltage in volts and the current in amperes or amps. This also equates to a given amount of power (heat per time) of one joule/sec. 1000 watt is one kilowatt. One watt load that is powered for one hour will consume one Watthour of power.

Batteries are often rated in Ampere-Hrs. This is the number of amps that can be delivered in one hour. It is a figure of merit that gives a measure of the number of electrons able to be pushed down a wire by a battery. It would be like saying that in our water analogy that the persons doing the hand pump could only produce 100 gallons for one hour and this would store more power than some one that cold only do 10 gallons for one hour before pooping out. .

The following simple formulas result for DC circuits.
V (volts) = I (Current in amps) * R (Resistance in ohms)
P (power in watts) = V (Volts) * I (Current in amps)
Watt hours = watts * hours of use
Ampere-hours = Amp flowing * number of hours it will flow

These simple formulas are very valuable for determining what is needed in a circuit to make it work correctly, for understanding batteries, and power sources.

Series connected: When cells or batteries are connected positive terminal to negative terminal they are end to end they are said to be in series. See attached figure http://home1.gte.net/mikelob/WaterBuckets1.pdf

For a water flow analogy consider an output of one fire truck connected to the input of another fire truck. Can you predict the result? The last fire truck can shoot water much higher than any one truck. It would be the same amount of water but with much more pressure. This would work for a fire in a tall building. If using batteries it gives the result of adding up the voltages for each cell in the string. Christmas tree lights are hooked in series and the sum of the voltage across all the lights has to end up being the voltage the string is plug into or usually 115 volts.

Note that if one battery cell stops working then the flow is stopped or slowed down for the rest. Remember this when it comes to 12 volt batteries that are made up of 6 cells of 2 volts in series.

Parallel connected: When cells or batteries are connected with positive terminal to positive and negative to negative they are said to be in parallel. For a water flow analogy, consider 4 fire trucks in parallel side by side all pumping there water on a fire. One adds up the quantity of water from each to get the total volume flow.   Each is limited to the pressure that can be generated from only one truck so the pressure is the same for each. This would be good for a large low building fire. For batteries so connected the current adds up to be the some of each. The voltage ends up to be the same as any one of them.

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